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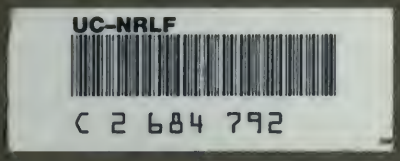

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MILITARY TOPOGRAPHY

AND

MAP READING

BY
CAPT. W. H. WALDRON
29TH INFANTRY

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Night Operations

A Department devoted to the interest of newly commissioned Infantry Officers, Officers of the Infantry Officers' Reserve Corps, and candidates for Commission.

Conducted by Capt. W. H. Waldron, 29th Infantry

MILITARY TOPOGRAPHY AND MILITARY MAP READING

For admission to the Officers' Reserve Corps or promotion to a higher grade in that corps, the provisions of General Orders No. 32 require of the candidate the making of a military topographic map (sketch) and a practical knowledge of map reading.

In the space available for this article it is impracticable to provide a text containing the process of military map (sketch) making. To give you a few hints that will help you over some of the rough places and to inform you where the detailed information on subject may be obtained is all that will be attempted.

The United States Infantry Association are the publishers and distributors of a book written by Capt. Loren C. Grieves, 30th Infantry, for the instruction of noncommissioned officers of the Army on the subjects of Military Sketching (which is, so far as you are concerned, the same as topographic map making) and Map Reading. This book is written in progressive lesson form and provides a text from which you will be able to master the subject within a reasonable length of time. The book may be had from the United States Infantry Association, Union Trust Building, Washington, D. C. The price is $1.00, postage paid. This book is highly recommended by the editor of this department.

The making of a military sketch may be accomplished in only one way, and that is to "go out and make it." You will never gain a mastery over the subject by sitting at your desk and studying the text-book. You will have to get out in the country and go through the process, not one but many times.

As in any other line of endeavor the first requisite for success is the possession of the proper tools for the work. If you start out with makeshifts, you are doomed to discouragement and failure.

1. You must have a drawing board, upon the surface of which the paper on which your sketch is to be drawn may be attached. The book department of the Army Service Schools at Fort Leavenworth, Kansas, has devised a sketching board that has met the requirements at that institution. It has a 3½-inch declinator and is probably the best that can be produced for a moderate price. The price of this board complete is $5.50. A folding head tripod for the board costs an additional $2.75.

2. Your next requisite is a means for attaining the direction of one point from another. This is supplied by the alidade ruler upon the six surfaces of which your scales may be pasted. The book department of the Army Service Schools at Fort Leavenworth also supplies this instrument at a cost of 20 cents each. It is made of seasoned wood, weighted with lead so that it will lie flat on the surface of the paper and not be disturbed by wind. It is triangular shaped in cross-section and is about 6 inches in length.

3. You will require some method for determining the slope of the ground at any given point and the difference in elevation of any two or more points. This is accomplished by reading the vertical angle. The regular instrument designed for this purpose is the clinometer, which is very expensive. As a substitute we use the slope board. On pages 43 to 45 of Captain Grieves' book are detailed instructions for laying off a slope board on your ordinary sketching board described in paragraph 1 above. You will find this sufficiently accurate for all practical purposes.

4. You will need lead pencils—4H and 6H are the best—a soft rubber eraser, thumb tacks and sketching paper. This latter should be carefully selected, for you cannot accomplish the necessary "rubbing out" on inferior paper.

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5. Finally you will require a scale of paces, which will be considered in detail later. As a refinement I would advise your procuring a canvas pencil holder.

Now let us see what all of this is going to cost you:

1 sketching board	$5.50
1 tripod for sketching board	2.75
1 alidade scales with stride and pace sheets	.20
1 eraser, soft rubber	.10
2 pencils, lead, 4H	.15
1 roll paper, sketching (20 yds.)	.65
1 pencil holder, canvas	.30
Thumb tacks, 2 dozen	.20
1 triangle, ambro, 6 inch (30 to 60)	.20
1 text-book, Captain Grieves'	1.00
Total cost	$11.05

All of these items except the last may be procured by addressing a letter to The Secretary, Army Service Schools, Fort Leavenworth, Kansas; the latter by addressing the United States Infantry Association, Union Trust Building, Washington, D. C.

You will need every one of these articles. To go out without them means unsatisfactory work and discouragement. This is a good outfit and one that you will use in the course of your instruction work in topography at the summer training camps for Reserve Officers. You will find it one of your best friends in the prosecution of your work there, and you will find it handy in your solution of tactical problems incident to the tactical walks in minor tactics that you will have, especially where you have an opportunity to indicate your dispositions by the means of a rough sketch.

In studying the subject, go over each lesson as laid down by Captain Grieves. They have been carefully planned. Get the elements of each firmly fixed in your mind. Practice the making of the conventional signs until you do not have to refer to the text-book for them. Get out in the country and actually make a map in accordance with the rules laid down in your text-book.

MILITARY MAP READING

Q. What is a military map?

A. A military map is one which shows the relative distances, elevations and directions of all objects of military importance in the area represented.

Q. What is map reading?

A. The ability to correctly interpret a map and to form a mental picture of the ground it is intended to represent.

Q. What are the essential elements of map reading?

A. 1. The conversion of map distances into corresponding ground distances; that is, an appreciation of the scale of the map.

2. A knowledge of the conventional signs and symbols employed by the map makers to represent the topographical features of the country included in the map.

3. An appreciation of direction.

4. A knowledge of contours and what they are intended to represent.

Q. What is the scale of a map?

A. The scale of a map is the ratio of the distance between two points on the map divided by the horizontal distance between the corresponding points on the ground.

Q. What are the scales prescribed for military maps in our service?

A. 1. Three inches equal one mile, for road sketches and maps.

2. Six inches equal one mile, for position sketches and maps.

3. Twelve inches equal one mile, for maps and sketches on which it is intended to organize defensive positions.

Q. How may the scale of a map be expressed?

A. 1. By a plain statement in words and figures of the relation between the map distance and the ground distance; for example," 3 inches to 1 mile." This means that any 3 inches on the map measured in any direction will represent 1 mile on the ground.

2. By a representative fraction in which the enumerator represents the map distance and the denominator represents the ground distance in the same unit of measure, thus $\frac{1}{10{,}560}$ would be the representative fraction for 6 inches to 1 mile; that is, one unit of measure on the map, as 1 inch, would represent 10,560 inches on the ground. One pen-

cil length on the map would represent 10,560 pencil lengths on the ground.

3. By a graphical scale in which a line is drawn on the map and divided into equal parts, the divisions being marked, not with their actual lengths, but with the ground distance that they represent.

Q. What are the two classes of scales?

A. Working scales and reading scales.

Q. What are working scales?

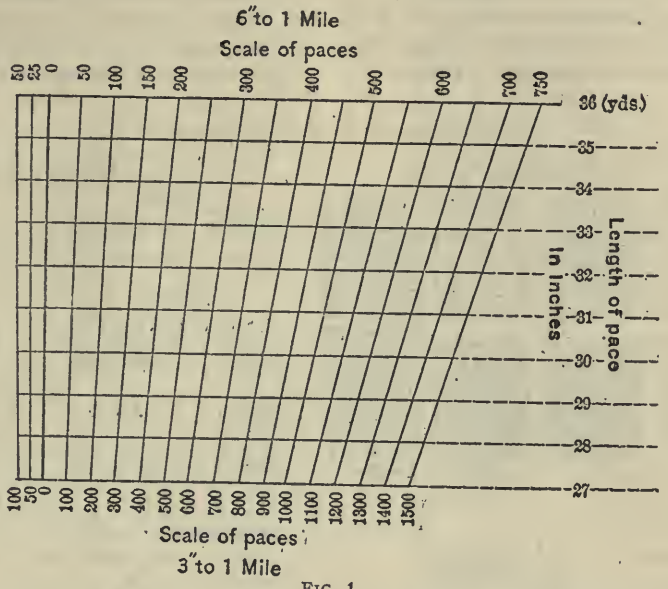


FIG. 1

A. Working scales are those representing the unit of measure with which the map was made; that is, paces, strides of a horse, length of a rope, etc.

Q. What are reading scales?

A. Reading scales are those made for laying off distances on the map and should be in some familiar unit of measure such as yards or feet. In some cases the reading scale may be identical with the working scale as where the working scale is paces of 36 inches, the corresponding reading scale would be yards.

Q. How would you determine the distance between two points on a map?

A. By measuring along the edge of a piece of paper the distance between the two points under consideration and applying this distance to the scale of the map and reading directly from it. To measure the distance from one point to another along a winding course, place the edge of the paper along each stretch, placing the point of a pencil at each successive point where the direction changes, the paper may be twisted around to follow the bends of the course until the total distance has been covered. Apply this total distance to the scale of the map and read direct. A few trials at this will perfect you in the method.

Q. What is a convenient formula for the solution of scale problems?

A. Let m = the number of units of measure to be represented by the scale line. In linear scales make this always 2,000, so there is nothing further to remember.

Let p = the number of inches in the unit of measure. For a scale of yards p would be 36, for a scale of 30-inch paces p would be 30, for a scale of meters p would be 39.37.

Let n = the denominator of the representative fraction. For 3 inches to the mile n would be 21,120; for 6 inches to the mile n would be 10,560, for 12 inches to the mile n would be 5,280.

Let x = the number of inches in the scale line to represent m units of measure.

Then $\frac{m \text{ times } p}{n} = x.$

For example: You desire to construct a scale of paces of 30 inches at 6 inches to 1 mile.

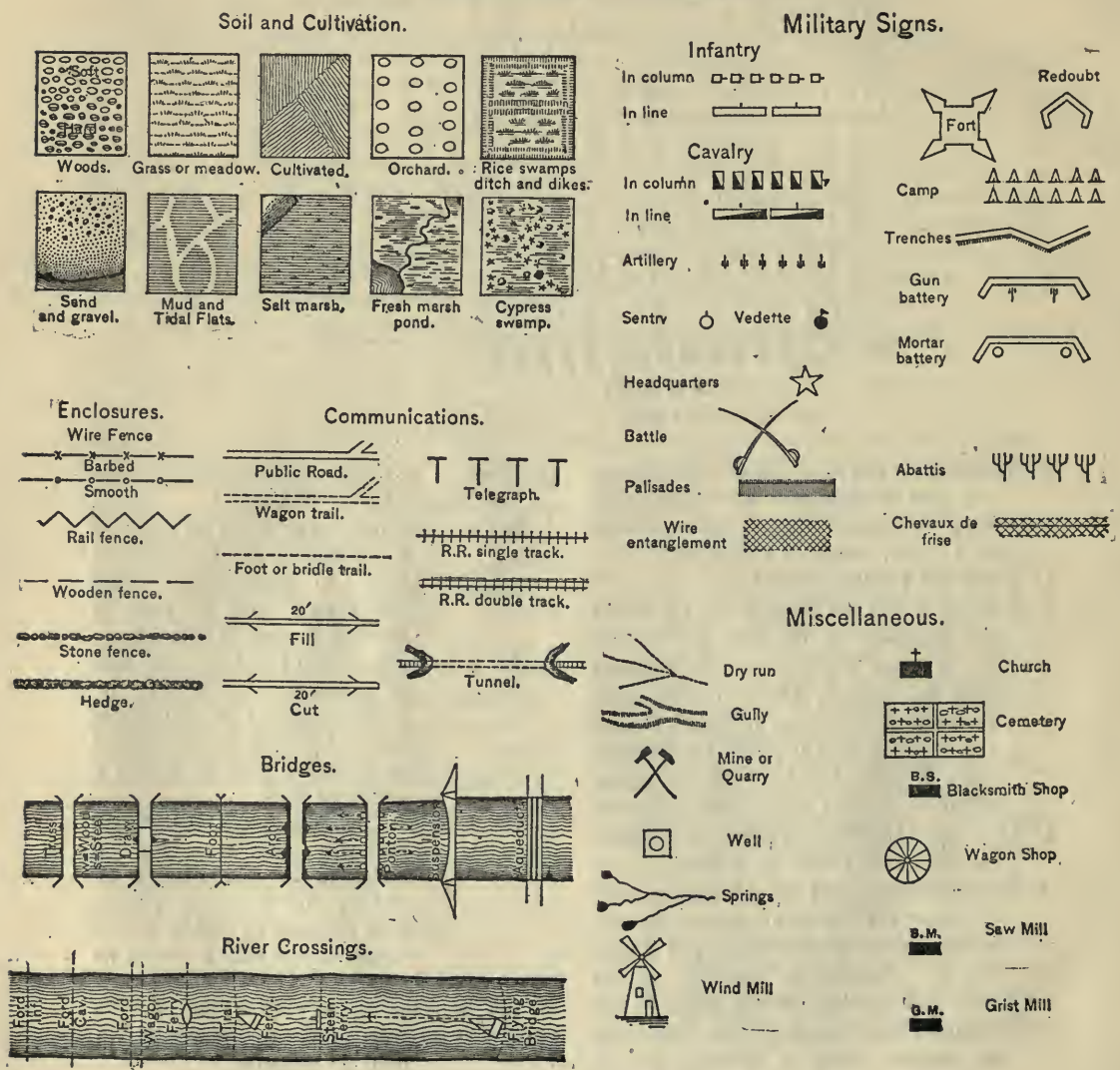
$$m = 2{,}000;\ p = 30;\ n = 10{,}560.$$

$$\frac{2{,}000 \times 30}{10{,}560} = x = 5.68 \text{ inches.}$$

Therefore a line 5.68 inches long would represent 2,000 paces. Draw a line 5.68 inches long and divide it into five equal parts of 400 paces each. Divide the left part into four equal parts each representing 100 paces.

Except as a means to your understanding of scales it is not necessary for you to go to the task of the solution of scale problems. All text-books on military sketching have all the scales that you will ordinarily use in your practical work. Figure 1 shows scales of paces from 27 inches to 36 inches for 3 inches to 1 mile 6 inches to 1 mile. This is all you will ever have any use for. (Taken from the Engineers' Field Manual.)

CONVENTIONAL SIGNS AND SYMBOLS



Q. How are the features of the country represented on maps and sketches?

A. By means of conventional signs and symbols.

Q. What characteristics have these conventional signs and symbols?

A. They are drawn to resemble, as near as practicable, the features that they are intended to represent.

There are published herewith plates of the ordinary conventional signs and symbols employed in map and sketch making in the United States service. In hasty sketches soil and cultivation may be indicated by simply writing the same in the areas instead of putting in the conventional signs. (See p. 66.)

You should practice making these conventional signs until you are familiar with them.

Q. How is the direction of one point from another stated in military map reading?

A. By the points of the compass. One point is said to be north, east, south or west from another point. When it lies between the north and east points it is said to be north (so many degrees) east; when between the east and south it is said to be south (so many degrees) east; when between the south and west it is said to be south (so many degrees) west, and when it is between the west and north it is said to be north (so many degrees) west.

Q. How is the north point of a map indicated?

A. By a line placed on the map at a convenient place with an arrow pointing to the north.

Q. Should a map come into your possession without having the north indicated, what conclusion would you draw as to the north point of the map?

A. The sides of the map generally run north and south. The lettering usually runs from east to west. These are pretty good guides.

Q. What do you understand by orienting a map?

A. Placing the map in such position that every road, stream, or other feature on the map will be parallel to its actual position on the ground; in other words, to make the map and the ground it represents coincide.

Q. What are the objects of orienting the map?

A. To enable you to pick out and identify on the ground all the features shown on the map.

Q. By what methods may a map be oriented?

A. 1. When the map has a magnetic meridian on it: Place the north and south line of the compass parallel to the magnetic meridian and turn the map until the north end of the needle points to the north of the circle. If the true meridian only is shown on the map you must know the declination and make allowance for it. If the declination is not more than 4 or 5 degrees the orientation on the true meridian or along the up and down borders of the map will be sufficiently accurate for all practical purposes.

2. When you have no compass or the meridian is not shown on the map: (*a*) If you can locate on the map your position on the ground and can identify another place on the map which you can see on the ground, shift the map around until the two points on the map are aligned on the distant point on the ground and you have the map oriented. (*b*) By reference to a straight road or line of railway on which you may be standing turn the map until the conventional symbol points in the same direction as the feature that it represents. In both of these methods the points used for orientation should be as far apart as possible and in any case they should be more than an inch apart on the map.

Q. How would you locate your position on the map?

A. 1. When the map has been oriented by compass. Sight along the ruler at an object on the ground at the same time keeping the ruler on the plotted position of this same object on the map. Draw a line towards yourself. Locate another point on the ground that is plotted on the map and repeat the process. The intersection of these two lines is your map position. These lines should form an angle of not less than 30 degrees and not more than 150 degrees.

2. If the map has been oriented by means of a straight line drawn between two map points, it will be necessary to draw

but one line from an object on the ground, and the intersection of this line with the line already on the map will be your location on the map.

Q. What are contours?

A. They are lines cut from the surface of the earth by imaginary horizontal planes spaced at equal vertical intervals from each other.

Q. What do contours show?

A. 1. The relative elevation of all points on the map.
2. The slope between any two points on the map.
3. The shape and form of the ground included within the limits of the map.

Q. What general characteristics have contours?

A. 1. All contours join or extend to the edge of the map. When they join they either represent a hill top or a depression—a hill when the smallest closed contour is higher than the adjoining one and a depression when it is lower.
2. Where the contours are equally spaced the slope is uniform. Where they are wide apart the slope is gradual and where they are close together it is steep.
3. A watershed is the high ground between two watercourses. The water flows away from it on both sides and is indicated by the higher contours bulging out towards the lower ones.
4. A watercourse is the low ground between two watersheds. The rain from both sides of it join in one stream and is indicated by the contours bending sharply towards the higher ones.
5. When two contours of different elevations join together and form one line they indicate a cliff. Where a higher one crosses a lower one it is an overhanging cliff.
6. A saddle or col is the space between the summits of two adjacent hills. It is indicated by two contours of greater elevation on two sides of it and two contours of less elevation on the other two sides.

Q. What do you understand by the term "horizontal equivalent?"

A. It is the horizontal distance on the ground between two contours.

Q. What is a scale of horizontal equivalents?

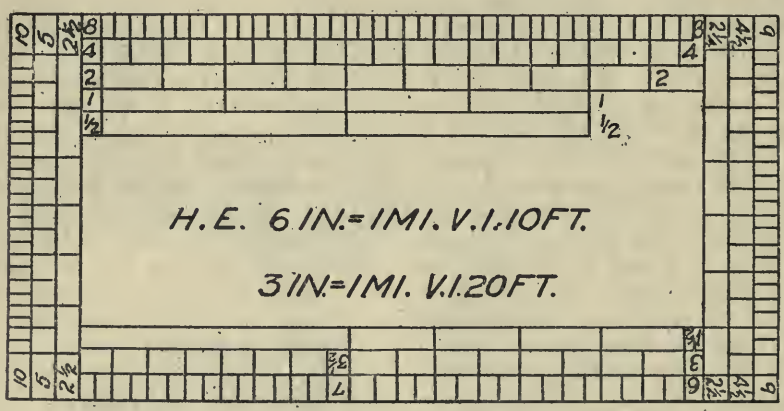


Fig. 2.—Scale of Horizontal Equivalents.

A. 1. The scale of horizontal equivalents is based on the fact that at a slope of one degree the ground will gain an elevation of 1 foot in 57.3 feet.
2. Thus where a vertical interval of 10 feet is being used this 10 feet elevation will be gained in 573 feet, when the slope is one degree. Where the slope is two degrees the 10 feet will be gained in one-half of 573 feet, etc.
3. To construct a scale of horizontal equivalents all we have to do is to first construct a scale of feet for the map. Then determine our vertical interval, say 10 feet. We then measure off successively on a line a map distance of 573 feet; this is the horizontal equivalent for one degree. We next measure off a map distance of 287 feet,

and this is the horizontal equivalent for 2 degrees slope; 191 feet for a 3-degree slope, and so forth up to the maximum degree of slope that we will encounter, usually 10 degrees.

4. This same scale of horizontal equivalents will answer for a map with a scale of 3 inches to 1 mile with a vertical interval of 20 feet; 6 inches to 1 mile with a vertical interval of 10 feet.
5. The scale of horizontal equivalents printed herewith has been made on the principle stated above. It runs from ½ degre to 10 degrees. (See Fig. 2.)

Practical Map Reading

Let us take the map published with this article and systematically read it.

2. What is the scale of the map? It is 3 inches equal 1 mile;[1] that is, 3 inches measured in any direction on the map is equal to 1 mile on the ground. Any 1½ inches on the map will represent ½ of a mile on the ground. We see that there is a representative fraction on the map. This is only another method of indicating the scale. How has it been determined? Remembering that a representative fraction is one reduced to unity in which the numerator represents the map distance and the denominator the ground distance we have:

$$\frac{\text{Map Distance}}{\text{Ground Distance}} = \frac{3 \text{ inches}}{1 \text{ mile}} = \frac{3 \text{ inches}}{63{,}360 \text{ inches}} = \frac{1}{21{,}120}$$

This may also be expressed 1 : 21,120; that is, one unit of measure on the map represents 21,120 of the same units of measure on the ground.

Q. What is the distance from the railroad crossing at Goldenville to the Boyd School House via the 621–630–Stock Farm road?

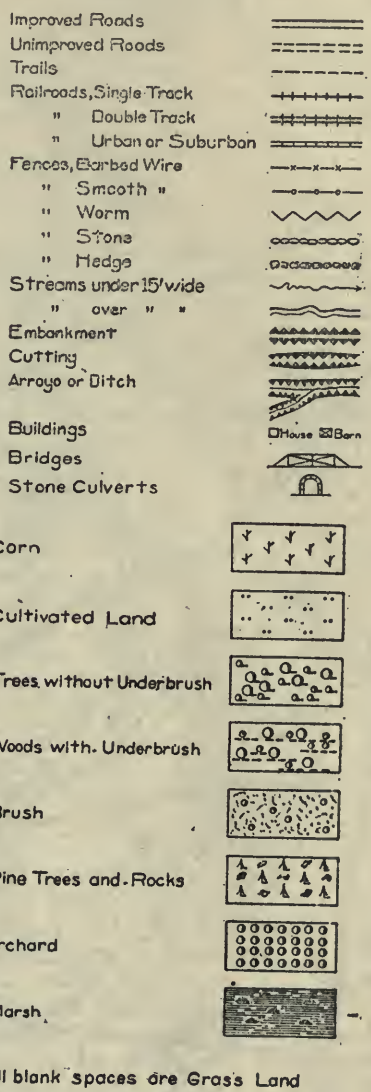
A. Measure off the distance along the edge of a slip of paper and apply it to the graphical scale at the bottom of the map. You will find it to be 4,540 yards.

Q. How long will it take a company of infantry to march from the cross-roads at Hunterstown to a railroad crossing at Goldenville? The company marches at the rate of 80 yards per minute.

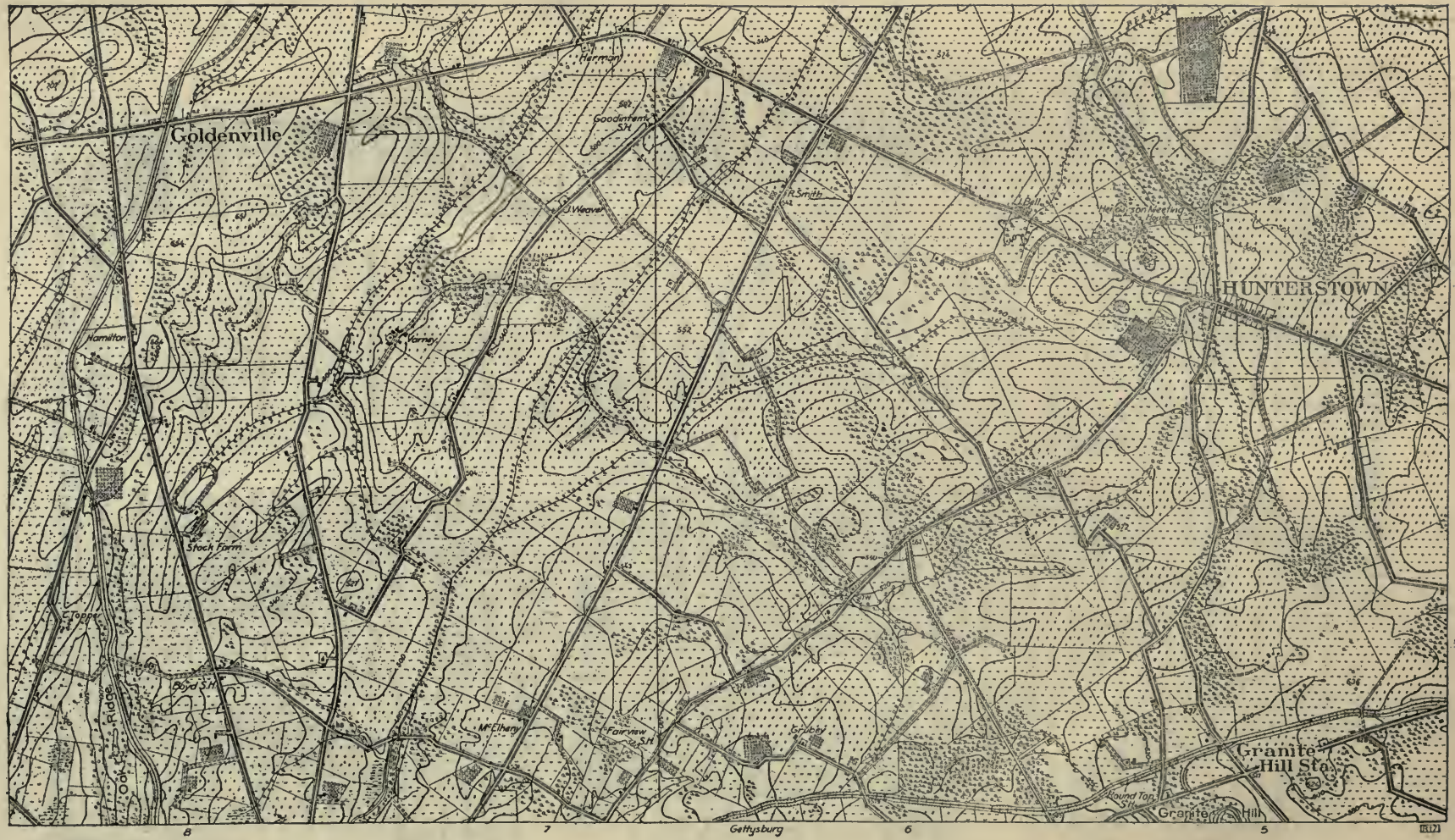
A. By measuring the distance we find that it is 8,230 yards. The company marching at the rate of 80 yards per minute would consume 101 minutes or an hour and 41 minutes.

You now proceed to a study of the convential signs used by the map maker. These conventional signs are drawn to represent as near as possible the feature as it appears on the ground. The conventional signs employed in making this map are shown below. Make a study of them until you know exactly what every mark on the map is intended to represent.

CONVENTIONAL SIGNS



[1]Reference should be made to the regular Hunterstown 3-inch map as the map given here has been very much reduced and is only for illustration.



Reduced from 1/2in War Game Map,
By the Engineer Dept Army Service Schools,
Fort Leavenworth Kas.

Scale
Mile
3000 Yards
M.D.
V.I.20 ft.
Datum is mean sea level.
1913

In working out problems use the Hunterstown 3-inch map.

You observe that this map has no meridian on it. How are you to determine directions? When a map has no meridian line it is pretty safe to assume that the reading matter runs from west to east and that the up and down edges of the map run north and south. A line through Fairview School House and Goodintent School House runs north and south. This line would serve as a meridian for work in the center of the map and the borders for meridian lines along the edges of the map. You observe a little V-shaped affair at the bottom of the map. The line to the right shows the true north and the one to the left shows the magnetic north; that is, the former, if the map were oriented on the ground, points directly to the north pole and the latter to the magnetic north. There are comparatively few places on the earth's surface where these lines coincide. In this case the magnetic declination is 7 degrees; that is, if you were to take a bearing with a compass there would be a variation of 7 degrees from the true north.

Q. What is the direction of Hunterstown from Fairview School House?

A. North 52 degrees east. This is determined as follows: Draw a line connecting Fairview School House with the cross roads at Hunterstown. Draw another line connecting Fairview School House and Goodintent School House. This latter is your meridian line. Lay a protractor with its 0–180 degree edge along the meridian with the center at Fairview School House. Read along the edge of the protractor to the point where the line connecting Fairview School House and Hunterstown emerges from under the protractor. This is the reading of the direction.

Q. What is the direction of Granite Hill Station from Goodintent School House?

A. South 41 degrees east. Use the same meridian line and pursue the same method as before indicated.

Q. What is the direction of Goldenville from Hunterstown Cross Roads? What is the direction of Boyd School House from Goodintent School House?

A. Work these out for yourself.

Note the Scale of Map Distances of contour intervals. Take the space to the left of the scale marked 1 degree. This means that at any place on the map where the contours are spaced the distances apart indicate that the ground at that point slopes just 1 degree. Where the ground is steeper the contours are spaced close together. By keeping this scale in your mind you can tell by observation the approximate slope of the ground at any point on the map.

Note the statement below the scale, V. I.: 20 feet. This means that the vertical distance between contours is 20 feet. So you know immediately that between every two contours, no matter what their distance apart may be, there is a vertical difference of 20 feet. Suppose the map had no such statement on it. How would you determine this contour or vertical interval? By an inspection of the map. You will observe that the contours from the ridge just south of Goldenville are numbered. These numbers indicate that the vertical interval between contours is 20 feet.

Q. What is the elevation of the Grubey House?

A. We see that this house lies about midway between the 580 and 600 contours; the elevation is, therefore, 590 feet.

Q. What is the difference in elevation between the McElheny House and the Hamilton House?

A. We see that the former has an elevation of 540 feet and that the 640 contour passes through the latter. The difference between these is 100 feet, so that the Hamilton House is 100 feet higher than the McElheny House.

Q. Where is the highest point on the map?

A. The 707-foot hill west of Goldenville.

Q. Where is the lowest point on the map?

A. The lowest point on any map will be found at the point where the largest body of running water leaves the map. This will be found in the southwest sector about 1,400 yards southeast of the Boyd School House.

In order to facilitate the further reading of this map secure a 10-cent package of "Crayolas" and proceed as follows:

1. With the blue crayola line out all the stream lines. This will show at a glance all the water system of the country covered by the map.

2. With the red crayola line out the 560-foot contour. This will show you the outline of the western watershed running along

Oak Ridge and its extension to the north; the watershed immediately west of the main watercourse and that to the east in the vicinity of Hunterstown.

3. With your green crayola line the 500-foot contour. Make note of its crooks and turns which indicate the shape of the ground throughout its course, then compare the green line with the red line indicating the 560 contour. You ought from this process to have a very good idea of the country covered by the map.

Tracing out the water system of the country included in the map we find that the main watercourse runs from northeast to southwest practically parallel to the 549–583–501–543–531 road. Numerous branches lead off to the east and west, the main one to the east crossing the above-mentioned road near 501, where it separates into two branches, one heading in the high ground in the southeast sector of the map and the other in the high ground just west of Hunterstown. The main branch to the west leaves the stream about 1,200 yards due west of 543, runs in a northwesterly direction to a point 700 yards southwest of the Varney place and then turns northeast and runs parallel to the main stream to the Hermon place and forming the watershed lying between the two streams. Another small stream leaves the main stream and heads near the Boyd School House. Another heads near the C. Topper place and runs a little west of south, forming with the main stream and its tributaries the watershed designated as Oak Ridge. Another small stream heads in the vicinity of Goldenville and runs southwest. This and the branches of the main stream form the watershed which lies to the north in prolongation of Oak Ridge. Over in the northeast sector of the map there is an independent system of watercourses that head to the south of and in the vicinity of Hunterstown, and these with the branches from the main stream form the watershed west of Hunterstown.

With your colored map you will be able to pick up all these points. The study should leave you with a good mental picture of the country covered by the map. You should be able to approximate distances and to measure the distance from one point to another with accuracy. You should have a good idea of the vegetation covering the country and how it would look from any point on the map. You should have knowledge of the shape of the ground, the steepness of slopes, etc. You should by an inspection of the map be able to solve the ordinary visibility problems that may come up, and any that do not admit of solution by inspection should be plotted out and a profile of sufficient extent made.

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